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Aging, Neuropsychology, and Cognition

A Journal on Normal and Dysfunctional Development

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/nanc20

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To cite this article: Yu Ping Wong & Hwajin Yang (2023) The influence of subjective socioeconomic status on executive functions in middle-aged and older adults, Aging, Neuropsychology, and Cognition, 30:4, 505-522, DOI: 10.1080/13825585.2022.2055738

To link to this article: https://doi.org/10.1080/13825585.2022.2055738

AGING, NEUROPSYCHOLOGY, AND COGNITION
2023, VOL. 30, NO. 4, 505–522
https://doi.org/10.1080/13825585.2022.2055738

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ABSTRACT

Subjective socioeconomic status (SES) has been shown to influence both psychological and biological outcomes. However, less is known about whether its influence extends to cognitive outcomes. We examined the relation between subjective SES and executive functions (EF)—a set of cognitive control processes—and its underlying mechanisms. By analyzing a nationally representative cohort of middle-aged and older adults (age 40–80) from the MIDUS 2 National Survey and Cognitive Project, we tested a serial mediation model with sense of control and health as sequential mediators. Using structural equation modeling, we found that subjective SES is indirectly related to EF via sense of control and health, above and beyond objective SES and other key covariates. Our study highlights one of the possible biopsychosocial mechanisms that underlies the relation between status-related subjective perceptions of inequalities and executive functioning skills in middle and late adulthood.

ARTICLE HISTORY
Received 29 September 2021
Accepted 15 March 2022

KEYWORDS
Subjective socioeconomic status; executive functions; perceived constraints; older adults; sense of control

Introduction

Executive functions (EF) are a set of domain-general cognitive control processes that facilitate goal-oriented mental operations such as planning, attention control, memory updating, multitasking, reasoning, and problem solving (Hedden & Gabrieli, 2004). Given that EF facilitate healthy aging and contribute to important outcomes such as life satisfaction in middle and older adulthood (Oh & Yang, 2021; Toh et al., 2019), a wealth of research has sought to identify the factors that influence EF in an aging population. Particularly, a growing body of literature suggests that socioeconomic status (SES) can influence EF in middle-aged and older adults. Greenfield et al. (2020), for example, found that higher levels of childhood SES are associated with better EF at age 65. Similarly, adulthood SES positively predicts performance on EF tasks in middle-aged adults (Shaked et al., 2018), and improvements in SES confer benefits on cognitive performance in middle-aged to older adults (Lyu & Burr, 2015; Turrell et al., 2002). These findings thus suggest that SES is a significant environmental force that shapes EF.

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SES can be operationalized either objectively or subjectively (Adler et al., 2000; Kraus et al., 2012). Objective SES defines one's status in terms of the absolute level of resources one possesses. It is indexed by economic indicators such as income, wealth, education, and occupation that can be factually reported with limited psychological influences from personality or mood (Tan et al., 2020). On the other hand, subjective SES refers to a perception of one's own socioeconomic position (Tan et al., 2020), and is typically indexed by global self–evaluations of one's standing in a social hierarchy. These two SES constructs are related but distinct. Subjective SES encompasses aspects of SES that are intangible and cannot be assessed using objective SES measures (Chen et al., 2012). For example, assessments of one's social resources, past income, life chances, and future prospects are included in subjective SES evaluations, but not in conventional objective SES measures (Adler et al., 2000; Adler & Stewart, 2007; Kim et al., 2021; Singh-Manoux et al., 2003). Further, since a cognitive evaluation underlies subjective SES, psychological processes, such as social comparisons, can easily shape subjective SES. Indeed, studies suggest that one's relative deprivation (i.e., perceived lack of resources or opportunities relative to others) is central to subjective SES (Greitemeyer & Sagioglou, 2016; Hoebel & Lampert, 2020).

Given these conceptual differences between subjective and objective SES, previous research has shown that subjective SES has a stronger predictive value relating to several key variables. A meta-analysis of 357 studies found that the association between subjective SES and subjective well-being (r = .22) was more robust than that between objective SES and subjective well-being (r = .16; Tan et al., 2020). Studies have also consistently shown that subjective SES predicts health outcomes above and beyond objective SES measures (Cundiff & Matthews, 2017; Ghaed & Gallo, 2007; Operario et al., 2004). Further, one study showed that the relation between objective SES factors and several health indices is reduced to non-significance after controlling for subjective SES measures (Singh-Manoux et al., 2005). These results suggest that subjective SES, compared with objective SES, explains the unique variance in psychological and health outcomes.

Although a large strand of the literature focuses on subjective SES and its predictability for physical or psychological outcomes, few studies have examined whether the influence of subjective SES extends to cognitive domains. Specifically, Zahodne et al. (2017) revealed that lower subjective SES predicted worse initial memory through the mediating variables of physical and mental health. However, subjective SES had no association with subsequent memory decline. Kim et al. (2021) similarly established that while subjective SES positively predicted baseline cognitive performance, its association with subsequent cognitive decline depended on the measure of subjective SES used. In particular, subjective SES measured in terms of participants' rank standing in the community negatively predicted cognitive decline. In contrast, subjective SES measured by participants' social standing within the country at large did not predict cognitive decline. Despite the empirical importance of these studies, the literature is still limited because of the relative lack of focus on higher-order controlled processes such as EF, which have been shown to predict the onset of dementia or cognitive impairment in older adults (Clark et al., 2012; Espinosa et al., 2009). Hence, it is crucial that we extend the literature to further determine the relation between subjective SES and EF, above and beyond objective levels of SES.

A possible mechanism for the relation between subjective SES and EF

Our study was guided by two goals. First, we aimed to examine the relationship between subjective SES and EF in middle-aged to older adults. Second, we sought to shed light on a possible mechanism that underlies this relationship. Subjective SES evaluations are determined by the array of economic and social resources one possesses throughout one's life, such as past SES, future economic prospects, and social capital, in comparison with others (Chen et al., 2012). Thus, appraisals of subjective SES implicate one's sense of relative deprivation, which has been theorized and shown to entail psychological (e.g., stress, negative emotions) and biological corollaries (e.g., chronic diseases; Beshai et al., 2017; Euteneuer, 2014; Wilkinson, 1996), all of which are in part associated with EF (e.g., Dupuy et al., 2015; Shields et al., 2017; Toh & Yang, 2020; Toh et al., 2019). Given this, it is plausible that both psychological and biological outcomes of subjective SES appraisals are involved in the link between subjective SES and EF. Accordingly, we propose a biopsychosocial mechanism whereby sense of control (a psychosocial factor) and health (a biological factor) serve as serial mediators that link subjective SES and EF in middle-aged and older adults. We elaborate below on the individual path relations implicated in the proposed serial mediation model.

First, we propose that subjective SES would be positively associated with a sense of control (i.e., the first psychosocial mediator in the serial mediation model), which refers to one's feeling of control over environmental events (Lachman & Weaver, 1998). The sense of control has two facets: personal mastery (i.e., beliefs about one's self-efficacy) and perceived constraints (i.e., beliefs about the presence of uncontrollable external barriers and obstacles). According to the theory of relative deprivation (Stouffer et al., 1949; Wilkinson, 1996), the perceived – compared with actual – lack of resources profoundly influences psychosocial outcomes. In light of this, a subordinate rank and perceptions of possessing fewer resources than others probably undermine one's belief in one's ability to achieve the desired outcomes. In support of this, Kraus et al. (2009) found that individuals of lower subjective SES endorse attribution styles characterized by an external, rather than internal, locus of control. Further, it has been suggested that the social resources associated with subjective SES appraisals are important in forming one's sense of control in middle to late adulthood (Antonucci & Jackson, 1987; Lachman & Weaver, 1998; Lang et al., 1976). Together, subjective SES would be positively associated with a sense of control (i.e., higher mastery and lower perceived constraints) in middle-aged and older adults.

Next, we propose that a sense of control would in turn be positively associated with health outcomes (i.e., the second mediator). The relation between sense of control and health is well established, with a higher sense of control associated with lower rates of cardiovascular diseases and mortality (Bailis et al., 2001; Seeman & Lewis, 1995; Ward, 2013). The belief that individuals can control their environments indicates that they possess the resources to cope with challenges, thus making the environment more predictable. This, in turn, perhaps reduces stress and stress reactivity, contributing to better health (Lachman, 2006; Robinson & Lachman, 2017). Consistent with this, studies have shown that those with a high sense of control have lower cortisol responses to stress (Liu et al., 2021; Müller, 2011). Moreover, a sense of control motivates individuals to engage in health-enhancing behaviors since they consider themselves responsible for their outcomes (Bandura et al., 1999; Marmot, 2004).

Further, as aging weakens the stress response system in the body (Vitlic et al., 2014), older adults with a lower sense of control may become more vulnerable to stress, which would in turn negatively affect their health more (Cox, ; Griffiths). Thus, it is plausible that sense of control is positively associated with health outcomes in middle-aged and older adults.

Lastly, we propose that health would be positively associated with EF. In particular, medical conditions have been suggested to have deleterious impacts on EF (Schillerstrom et al., 2005). For example, Kilander et al. (1998) found that patients with high diastolic blood pressure at age 50 had poorer performance in EF measures 20 years later. Other medical conditions, such as hypertension, can also cause damage to regions of the brain crucial for EF, thereby affecting EF performance (Williams et al., 2017). Conversely, engagement in physical activities, which is essential for health, stimulates biological processes conducive to cognitive health (Allan et al., 2016), and exercise interventions can similarly improve cognitive functions (Colcombe & Kramer, 2003). In light of these findings, health would be positively associated with EF. Taken together, our proposed biopsychosocial mechanism for the relation between subjective SES and EF through a sense of control and health is plausible.

The present study

We formed the following hypotheses. First, given that subjective SES takes into account one's perception of the economic and social resources that are pivotal in shaping a sense of control in middle-aged and older adults, we hypothesized that subjective SES would be positively associated with a sense of control. Second, we hypothesized that an enhanced sense of control would be positively associated with health outcomes. This is in line with the literature that supports positive relations between sense of control and health, reduced mortality rates, and other health benefits such as reduced stress reactivity (Ward, 2013; Rodin & Langer, 1977).

Finally, given the theories that highlight the cognitive benefits of having good physical health (Colcombe & Kramer, 2003; Schillerstrom et al., 2005), we hypothesized that health would be positively associated with EF. Overall, we expected that a higher subjective SES would be indirectly related to EF in middle-aged and older adults, through an improved sense of control and positive health outcomes.

We tested a serial mediation model by analyzing a nationally representative adult cohort from the Midlife in the United States National Survey 2 (MIDUS 2 Project 1, 2004–2006; Ryff et al., 2004 –2006) and its Cognitive Project (MIDUS 2, 2004–2006; Ryff & Lachman, 2017). Measures of subjective SES, sense of control, and health were administered as part of Project 1 of MIDUS 2, before EF tasks which were part of the cognitive project of MIDUS 2, enabling us to examine our proposed serial mediation model cross-sectionally.

To resolve the task-impurity problem that is known to be inherent in tasks that assess EF (Hartanto & Yang, 2019), we used a latent variable approach to account for potential measurement errors driven by non-executive processes such as color perception in each EF task. Further, to verify our theoretical model, we performed additional sensitivity analyses by running two serial mediation models, in which the order of the two mediators (sense of control and health) and that of the predictor (subjective SES) and first-order mediator (sense of control) were reversed.

Methods

Participants and Study Design

Of the participants who took part in MIDUS 2, a subsample of 4,816 participants was recruited as part of the Cognitive Project (Ryff & Lachman, 2017), in which a battery of cognitive tasks was administered over a 30-minute phone interview (Ryff & Lachman, 2017, 2017). For our data analysis, we adopted the following inclusion criteria: (a) complete responses; (b) trials without technical malfunctions or distraction from external events; (c) more than 75% accuracy on all EF tasks. A total of 3,922 participants (aged 40 to 84; M = 55.3 SD = 12.1) were included in our analyses (See, Table 1 for descriptive statistics and zero-order correlations).

Measures

Subjective SES

Subjective SES was measured using the MacArthur Scale of Subjective Social Status (Adler & Stewart, 2007). Participants indicated where they stood on a 10-rung ladder that represents different social ranks in their community (1 = *highest standing*, 10 = *lowest standing*). Scores were reverse-coded such that higher scores reflected higher subjective SES. This scale has been shown to have good test–retest reliability and construct validity across different populations (Cundiff et al., 2016; Giatti et al., 2012).

Sense of control

Participants' sense of control was assessed by a 12-item questionnaire (Lachman & Weaver, 1998) on a 7-point Likert scale (1 = *strongly agree*, 7 = *strongly disagree*). The scale contained two subscales: (a) personal mastery (four items; α = .739) to assess self-efficacy in carrying out personally important goals (e.g., "I can do just about anything I really set my mind to") and (b) perceived constraints (eight items; α = .866) to assess one's perception of uncontrollable obstacles that interfere with goal achievement (e.g., "There is little I can do to change the important things in my life"). Items were reverse coded, with higher scores reflecting higher standing in each dimension.

Health status

Multiple aspects of health status were assessed using several measures – (a) functional limitations assessed by two different scales, (b) present physical health and perceived overall health assessed by two single-item measures, and (c) chronic disease prevalence with reference to the previous 12 months. Functional limitations – i.e., the extent to which health limits one's ability to perform several activities – were assessed by the two-item Basic Activities of Daily Living (BADL) scale, which measures one's present capabilities in managing basic physical needs (e.g., bathing or dressing), and the seven-item Instrumental Activities of Daily Living (IADL) scale, which measures one's present capabilities in managing

Table 1. Descriptive statistics and bivariate zero-order correlations.

	Min	*Max*	*VIF*	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12
1. Income	2.15	5.48	1.37	4.73	0.42	1.00											
2. Education	1.00	12.00	1.23	7.32	2.52	**0.34**	1.00										
3. Sex	1.00	2.00	1.09	1.53	0.50	**−0.14**	**−0.10**	1.00									
4. Age	40.00	84.00	1.33	57.35	10.95	**−0.36**	**−0.13**	−0.01	1.00								
5. Subjective SES	1.00	10.00	1.28	6.54	1.81	**0.13**	**0.20**	**−0.13**	**0.14**	1.00							
6. Chronic diseases	0.00	30.00	1.44	3.57	2.47	**−0.24**	**−0.14**	**0.12**	**0.18**	**−0.11**	1.00						
7. Physical self-rated health	1.00	5.00	2.12	3.56	1.01	**0.26**	**0.25**	−0.01	**−0.14**	**0.18**	**−0.41**	1.00					
8. Overall self-rated health	1.00	10.00	2.07	7.39	1.56	**0.18**	**0.15**	0.01	**−0.04**	**0.20**	**−0.41**	**0.67**	1.00				
9. Daily activities (instrumental)	1.00	4.00	3.16	3.74	0.87	**0.30**	**0.23**	**−0.14**	**−0.32**	**0.10**	**−0.49**	**0.55**	**0.50**	1.00			
10. Daily activities (basic)	1.00	4.00	2.33	3.21	0.58	**0.24**	**0.20**	**−0.06**	**−0.20**	**0.09**	**−0.40**	**0.45**	**0.42**	**0.75**	1.00		
11. Perceived constraints	1.00	7.00	1.65	2.54	1.15	**−0.20**	**−0.18**	**0.08**	0.03	**−0.35**	**0.29**	**−0.29**	**−0.30**	**−0.29**	**−0.25**	1.00	
12. Personal mastery	1.25	7.00	1.45	5.73	1.02	**0.10**	**0.05**	**−0.05**	−0.03	**0.29**	**−0.14**	**0.19**	**0.23**	**0.17**	**0.13**	**−0.51**	1.00
13. Executive functions	−3.05	2.91	-	0.07	0.90	**0.34**	**0.42**	**−0.11**	**−0.40**	**0.05**	**−0.21**	**0.27**	**0.16**	**0.29**	**0.26**	**−0.17**	**0.04**

more complex activities required for independent living (e.g., lifting or carrying groceries). Participants reported their responses on a 4-point Likert scale (1 = *a lot*, 4 = *not at all*), and each scale's mean scores were calculated. Higher scores represent healthier functioning.

Next, two single-item measures were developed as part of the MIDUS project (Ryff & Lachman, 2017) to assess self-reported physical health and perception of overall health; participants rated their current physical health on a 5-point scale (1 = *poor*, 5 = *excellent*) and their perceived overall health status on a 10-point scale (0 = *Worst*, 10 = *Best*). Higher scores on both items represent better health. Previous studies suggest that ratings on global self-report measures remain stable over time (Miilunpalo et al., 1997) and are predictive of important health outcomes in middle-aged and older adults such as mortality (Idler & Benyamini, 1997; Schnittker & Bacak, 2014), use of health services (Miilunpalo et al., 1997), and functional health decline (Hirosaki et al., 2017). It is thus valid to use these single-item measures to index health status.

Lastly, participants reported the number of chronic diseases experienced in the past 12 months, from a list of 30 chronic conditions (e.g., cancer, HIV). The number of chronic conditions experienced was deducted from the maximum possible number of 30 so that higher scores represent better health.

Executive functions (EF)

The six subtests of the Brief Test of Adult Cognition by Telephone and the Stop and Go Switch Task (SGST) were used to assess various cognitive abilities. Of these, five tasks that have been shown to load on to the construct of EF were included in this study (Lachman et al., 2010). Specifically, in the digit span backward task, which measures working memory capacity, participants were presented with a series of numbers and asked to repeat them backward. The maximum number of digits recalled up to eight was recorded. In the categorical fluency task, which served as an indicator of verbal fluency and processing speed (Drachman & Leavitt, 1972), participants had to name as many things that belong to a given category as possible within 1 min. Similarly, the backward counting task, another measure of processing speed, required that participants count backward from 100 as fast as possible for 1.5 min. The number of correctly reported responses was recorded. The number series task was used as a measure of fluid intelligence and reasoning (Salthouse & Prill, 1987). In the task, participants were given strings of numbers (e.g., 2, 4, 6, and 8) and asked to deduce the next number in the series (i.e., 10). The total number of correct answers was recorded. Lastly, in the SGST, which measures task-switching abilities, participants were asked to respond according to different verbal cues, which are "normal" (i.e., congruent trials) versus "reverse" (i.e., incongruent trials). When prompted with a normal cue, participants should answer "stop" and "go" in response to verbal targets RED and GREEN. When prompted with a reverse cue, participants had to switch their responses by saying "go" and "stop" in response to RED and GREEN. The two types of cues were intermixed and presented randomly during the task. Participants' mean response times (RT) on switch (i.e., different cues were given consecutively) and nonswitch (i.e., the same cue was given consecutively) trials were used to index performance. Longer RTs denote poorer performance.

Results

Analysis plan

We conducted analyses using Mplus 7.4 (Muthén & Muthén, 1998) with maximum likelihood estimation. Sense of control, health, and EF were modeled as latent variables and subjective SES as a manifest variable. Two scales (IADL and BADL), two single-item measures of health, and chronic diseases were indicators for the latent factor of health. Indicators for the two latent factors of the two facets of a sense of control (personal mastery and perceived constraints) were their respective subscale items. Similarly, the five EF tasks served as indicators for the latent variable of EF. To confirm that the indicators represent their underlying latent constructs, confirmatory factor analysis (CFA) was performed to determine the fit of each measurement model to the data (See, Table 1 and Figure 1). Thereafter, we performed separate structural equation modeling analyses with age, sex, education, occupation, and total household income as covariates, to examine the mediational relationship between subjective SES and the latent variable of EF, through a sense of control and health. We did this for each facet of a sense of control. Model fit was evaluated based on the following criteria: root mean square error of approximation (RMSEA) < .08, confirmatory fit index (CFI) and Tucker-Lewis index (TLI) close to .95, and standardized root mean square residual (SRMR) < .08 (Hu & Bentler, 1999). All reported path coefficients are standardized estimates indicative of the effect sizes (Muthen, 2019).

Measurement models

The measurement model for each facet of sense of control showed a good model fit (for all model fits, see, Table 2), and all factor loadings on both latent variables were significant, *p*s < .001 (see Figure A1 in the Appendix for all individual measurement models). Similarly, the measurement model for health showed a good fit with significant loadings, *p*s < .001.

For the measurement model of EF, previous studies suggest that the construct of EF for older adults is best represented by either one-factor or two-factor models (Adrover-Roig et al., 2012; De-frias et al., 2006; Ettenhofer et al., 2006; Khoo & Yang, 2020). Thus, we tested both models. For the two-factor model, we modeled the latent construct of EF in line with previous studies (Khoo & Yang, 2020): Factor 1 (goal maintenance/ processing speed) with category fluency and backward counting tasks as indicators and Factor 2 (updating/ inhibiting) with number series, digit backward, and switching tasks as indicators. We found that while the one-factor model showed a reasonable fit to the data, the two-factor model showed poor fit (see, Table 2). Further, the two-factor model showed an interfactor correlation coefficient of greater than 1 (r = 1.095), implying model misspecification. Given these, we chose the one-factor model as our primary measurement model of EF. Finally, the full measurement model including the predictor, the two mediators, and the outcome variable showed excellent model fit.

Structural models

We ran a structural model with a one-factor model of EF. Supporting our hypothesis, the relationship between subjective SES and EF was serially mediated by sense of control and health. The indirect effects of subjective SES on EF with each respective

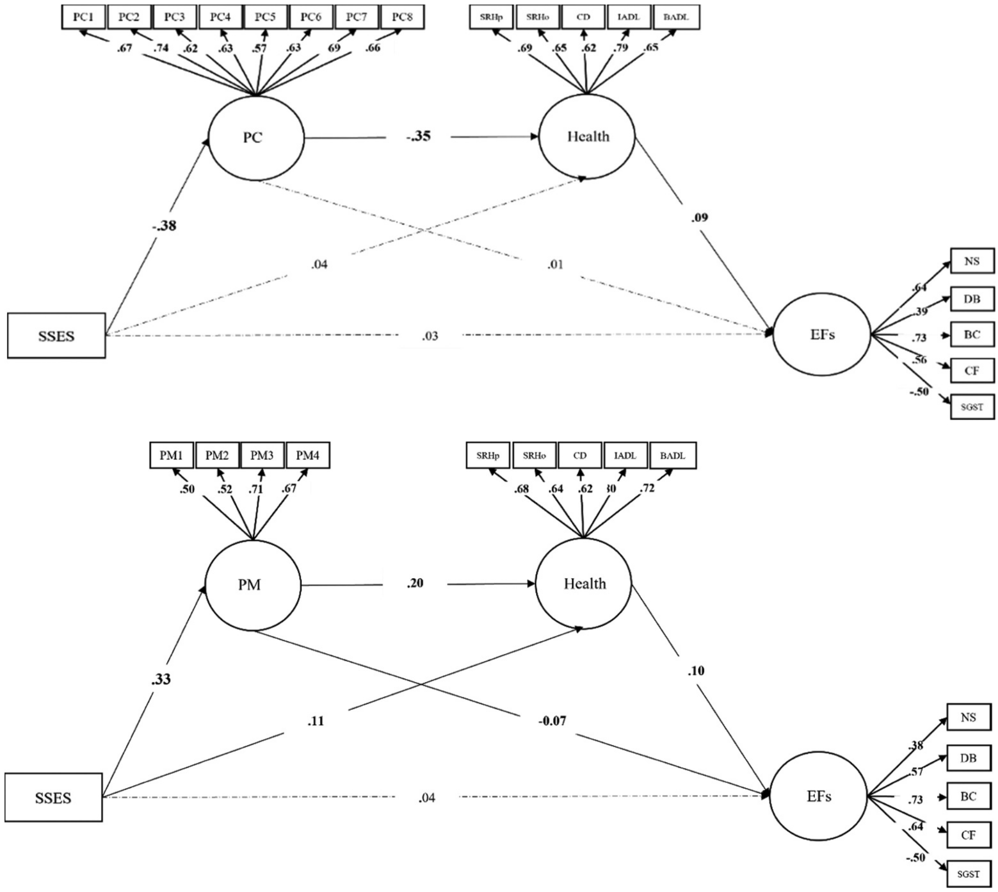

Figure 1. Structural equation model for the relation between subjective SES and EF via perceived constraints and health as mediators (top) and personal mastery and health as mediators (bottom panel). Circles represent latent variables. Squares and rectangles represent indicators (manifest variables). Longer solid and dotted lines signify statistically significant (at the .05 level) and non-significant standardized path coefficients, respectively. Values next to single-headed arrows connecting latent variables and indicators signify standardized factor loadings, which are all significant (at the .05 level). SSES = subjective SES; PC = perceived constraints; PM = personal mastery; SRHp = physical self-rated health; SRHo = overall self-rated health; CD = chronic diseases; IADL = Instrumental Activities of Daily Living; BADL = Basic Activities of Daily Living; DB = digit backward; CF = category fluency; BC = backward counting; NS = number series; SGST = Stop and Go Switch Task.

facet of a sense of control (see, Figure 1) were significant ($\beta_{\text{perceived constraints}} = .012$, $p = .022$; $\beta_{\text{personal mastery}} = .006$, $p = .015$). Specifically, higher subjective SES was associated with a lower level of perceived constraints ($\beta = -.383$, $p < .001$), which was also associated with better health ($\beta = -.354$, $p < .001$). Health was in turn associated with better EF ($\beta = .087$, $p = .017$). Regarding the other facet of sense of control, higher subjective SES was associated higher personal mastery ($\beta = .331$, $p < .001$), which was associated with better health ($\beta = .202$, $p < .001$) and, in turn, with better EF ($\beta = .096$, $p = .005$).

Table 2. Fit Indices for Measurement and Structural Models.

	χ^2	df	RMSEA	CFI	TLI	SRMR
Measurement Models						
Perceived constraints	107.848***	16	0.044	0.989	0.980	0.017
Personal mastery	6.27*	1	0.042	0.998	0.987	0.006
Health status	4.928	3	0.014	1.000	0.999	0.004
Executive functions (EF)						
One-factor model	32.24***	3	0.053	0.991	0.971	0.014
Two-factor model	139.626***	4	0.098	0.959	0.898	0.031
Full measurement model	936.24***	194	0.033	0.967	0.961	0.031
Structural Models						
One-factor model of EF						
Perceived constraint	825.316***	214	0.039	0.945	0.933	0.033
Personal mastery	696.841***	135	0.048	0.926	0.905	0.037

Note. * $p < .05$; ** $p < .01$; *** $p < .001$.

Further, when we subsequently analyzed our data without the 75% accuracy inclusion criteria to capture a wider range of accuracy on EF tasks, we found similar results. The indirect effects of subjective SES on EF with regard to each facet of sense of control were significant ($\beta_{\text{perceived constraints}} = .009$, $p = .030$; $\beta_{\text{personal mastery}} = .006$, $p = .010$). Specifically, higher subjective SES was associated with lower perceived constraints ($\beta = -.353$, $p < .001$), which was associated with better health ($\beta = -.355$, $p < .001$), which was in turn related to better EF ($\beta = .076$, $p = .025$). Conversely, subjective SES was associated with higher personal mastery ($\beta = .319$, $p < .001$), which was associated with better health ($\beta = .203$, $p < .001$, and ultimately better EF ($\beta = .093$, $p = .003$).

To further verify our theoretical model, we conducted sensitivity analyses with (a) the order of the mediators (sense of control and health) reversed and (b) the order of the predictor and first mediator reversed (subjective SES and sense of control). For this, we first created a latent variable of sense of control with subscale scores of perceived constraints and personal mastery as indicators. When the order of the two mediators (sense of control and health) were interchanged, we found that the indirect effect of subjective SES on EF was non-significant ($\beta_{\text{sense of control}} = .001$, $p = .57$). Similarly, when the order of subjective SES and sense of control was swapped, we found a null indirect effect as well ($\beta_{\text{sense of control}} = -.001$, $p = .290$). Taken together, these results lend support to the robustness of our serial mediation model that possessing higher subjective SES enhances one's sense of control, which supports better health and then ultimately better EF.

Discussion

Our study contributes to the literature in two ways. First, using a large representative sample, a comprehensive battery of tasks for EF, and rigorous structural equation modeling, we established that subjective SES is positively associated with EF in middle and old age, above and beyond objective SES indicators. Given that objective SES is rooted in tangible economic resources, while subjective SES is further shaped by psychological and social influences (Tan et al., 2020), our study suggests that the less tangible aspects of SES, such as social resources, life chances, and feelings of relative deprivation, could influence EF in middle and late adulthood as well.

Our second notable contribution is that our study elucidates one of the possible biopsychosocial mechanisms by which sense of control and health serially mediate the relationship between subjective SES and the latent variable of EF. Existing theories postulate that health-related pathways underlie the relation between subjective SES and cognitive outcomes. In line with this, Zahodne et al. (2017) revealed that altered cortisol responses associated with low subjective SES led to a greater risk of cognitive impairment. Similarly, Kim et al. (2021) argued that subjective SES would influence cognition through its impact on health. Our findings not only support these findings but also identify the crucial role of sense of control in a more extended mediation model. Although sense of control has been proposed to underlie the link between status-related inequalities and health (Adler et al., 1994; Marmot, 2004), its critical mediating role in the relationship between subjective SES and EF – i.e., higher-order control processes – has seldom been examined in the literature. Taken together, our study highlights the indirect link between subjective SES and EF through sense of control and health, thereby supporting the view that psychological processes are crucial corollaries of subjective SES (Marmot, 2004; Wilkinson, 1996).

More specifically, our finding of the significant pathway from subjective SES and sense of control suggests that subjective SES could indeed be an important factor that shapes sense of control. This is also consistent with the growing body of research highlighting the importance of subjective SES in shaping sense of control (Kraus et al., 2009; Lachman & Weaver, 1998). However, due to the cross-sectional nature of our study, it is difficult to ascertain the temporal precedence of subjective SES over sense of control although previous empirical studies and theories support our contention. For example, Kraus et al. (2009) showed that successful manipulations of sense of control did not change one's subjective SES. Thus, this weakens the possibility that sense of control shapes subjective SES. Further, a growing body of literature suggests that subjective SES peaks in midlife, as individuals acquire the maximum capabilities and opportunities, and remains stable in the transition to older adulthood, as individuals seek to maintain positive perceptions of themselves at this developmental stage, despite the age-related changes that might threaten their status perceptions (physical decline, aging stereotypes; Robertson & Weiss, 2018; Weiss & Kunzmann, 2020). Given the relative stability of subjective SES in middle and late adulthood, it is hence more likely that subjective SES precedes sense of control, as in our proposed serial mediation model.

Next, the positive relation between sense of control and health is in line with well-established theories and empirical studies. In our study, we created a latent variable of health using various health indicators. This enables us to obtain a purer measure of health, as different dimensions of health contribute to our latent variable (e.g., chronic diseases, functional limitations, and self-reported perception of health). Given that self-reported health measures are valid and more sensitive than objective health measures (Miilunpalo et al., 1997), our study provides important evidence for the relation between sense of control and subjective health status.

Finally, the negative association between health and EF is similarly consistent with existing literature. A limitation of the existing studies is that EF is often assessed using single tasks or indexed with standardized scores across several tasks. Given the task impurity issues inherent in EF tasks since they not only tap on one's EF ability but also other abilities such as those to discriminate colors, it is important to use a latent variable approach to exclude idiosyncratic non-EF processes specific to each EF task (Miyake et al., 2000). The use of a latent variable approach in our study, therefore, addresses this critical methodological issue in the literature that has examined the link between health and EF.

Our study is not without limitations, and thus requires caution in interpreting the findings. First, notwithstanding the use of mediational analysis, it is difficult to establish a causal relation between subjective SES and EF due to the correlational nature of our analysis (Pirlott & MacKinnon, 2016). Thus, it is still possible that those who are high in EF tend to have better health and experience a greater sense of control.

Second, our assessment of health is limited to physical health and does not consider mental health, which could affect EF; studies have shown that psychopathologies, such as mood disorders, impair EF (Snyder, 2013; Snyder et al., 2019). Since sense of control has been shown to predict the prevalence of such disorders (Benassi et al., 1988; Chou, 2005), it is plausible that mental health also accounts for the relationship between subjective SES and EF. Thus, future studies should consider mental health in the mediational model.

Third, our study does not explicate the specific elements of subjective SES that influence EF. Theoretically, subjective SES is shaped by numerous subfactors, such as perceived deprivation or social resources, which can uniquely influence EF. Several studies have attempted to identify the determinants of subjective SES (Miyakawa et al., 2012; Shaked et al., 2018; Singh-Manoux et al., 2003). However, the cross-sectional nature of these studies renders it difficult to ascertain whether the proposed determinants (such as depression) indeed shape subjective SES or, conversely, whether they are consequences of subjective SES. Further, these existing investigations have yielded mixed findings. While Miyakawa et al. (2012) contends that depression influences subjective SES, Singh-Manoux et al. (2003) disagrees. Since there is, till now, no consistent or strong evidence for the determinants of subjective SES, future research should use more refined distinctions between the specific elements of subjective SES and examine their roles in EF.

Finally, given that the MacArthur ladder scale has two versions, our study used the community version instead of the country version. The former measures one’s rank standing in the community, while the latter measures one’s rank standing in the country. Studies have found that in the country-based measure, objective resources such as education and income are used to appraise subjective SES (Adler & Stewart, 2007). In contrast, psychosocial factors, such as social networks and feelings of respect, play a more important role when measured by the community-based ladder (Adler & Stewart, 2007). Since the two measures have been found to have different impacts on cognitive decline (Kim et al., 2021), it would be interesting to investigate whether the country-based measure would lead to a different or similar pattern of findings. Nevertheless, since the community ladder appears to yield a more accurate depiction of one’s subjective SES, our findings provide strong support for our hypothesis regarding the relation between subjective SES and EF.

Conclusion

Our study demonstrates that the subjective dimension of SES is indirectly related to EF, through a biopsychosocial mechanism involving a sense of control and health. Given that one’s sense of control is malleable and influenced by socio-cultural factors (Robinson & Lachman, 2017; Lachman & Weaver, 1998; Langer & Rodin, 2021), our study informs intervention programs aimed at alleviating status-related inequalities, providing valuable insights into the ways the negative influence of low subjective SES on EF can be mitigated in middle and late adulthood. Specifically, using interventions, one's misconceptions about sense of control can be restructured, and the belief that control is malleable can be instilled. Supporting this, previous studies suggest that technology-related interventions can improve seniors' sense of empowerment and control (Shapira et al., 2007). Thus, it seems plausible that interventions to improve sense of control will effectively attenuate the strength of its relation to subjective SES and subsequently weaken its association with poorer health and cognitive outcomes. Overall, our study highlights that the barriers to cognitive performance in middle-aged and older adults can stem from subjective SES above and beyond objective SES experiences. Hence, it is important to focus on subjective SES, when resolving status-related inequalities in cognitive performance.

Authors' note

This study was supported by a Lee Kong Chian Fellowship awarded to Hwajin Yang.

Both authors contributed equally to this work.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix A

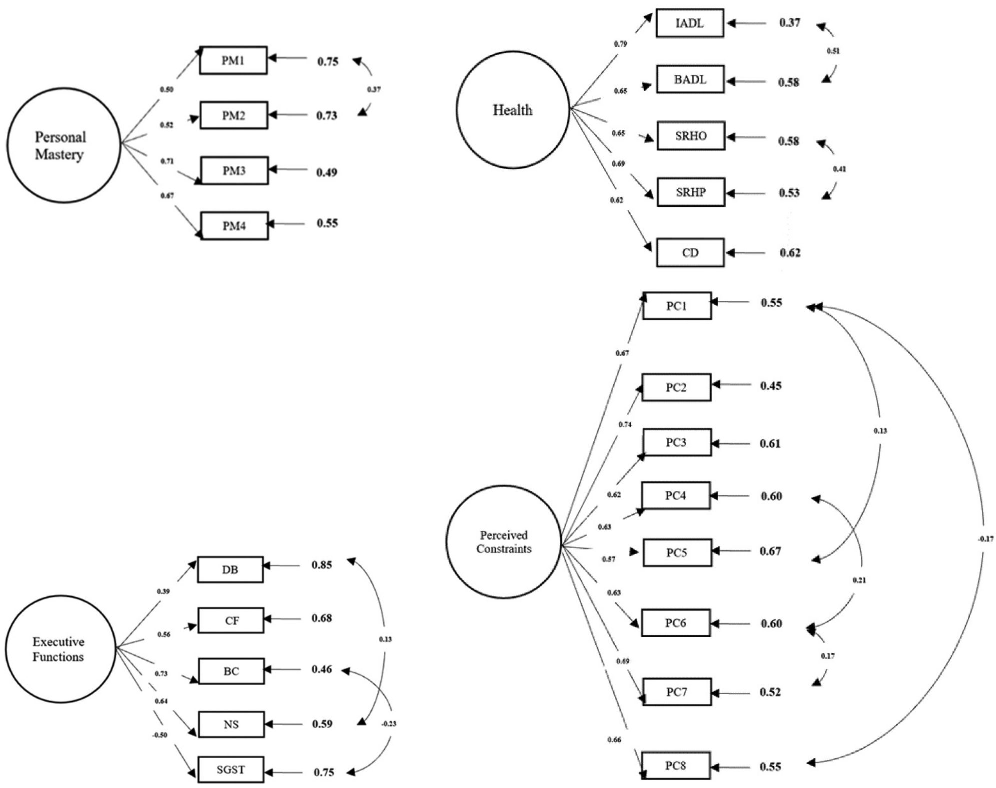

Figure A1. Individual measurement models of Personal mastery, Health, EF, perceived constraints with standardized estimates. Circles represent latent variables. Rectangles represent indicators (manifest variables). Values for long single-headed arrows signify factor loadings and those for short single-headed arrows represent error variances. Values for curved, double-headed arrows indicate interfactor correlations. PM= personal mastery; IADL= instrumental activities of daily living; BADL = basic activities of daily living; SRHO = self-reported overall health; SRHP = self-reported perceived health; CD = chronic diseases; DB = digit backward; CF = category fluency; BC = backward counting; NS = number Sseries; SGST = Stop and Go Switch Task; PC = perceived constraints. All bolded statistics are statistically significant at the .05 level.